DEFENSIVE BEHAVIOUR OF THE NEW GUINEA STICK INSECT *EURYCANTHA* (PHASMATODEA : PHASMATIDAE : EURYCANTHINAE)

G. O. Bedford*

(Plates xxiv and xxv)

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Synopsis

A description is given of presumed defensive behaviour in New Guinea phasmatids of the genus *Eurycantha,* which inhabit hollow tree trunks and stumps. When disturbed, adult males raise the abdomen in an S-shape and strike together the metathoracic legs which are heavily armed with spikes. Any restraining object tends to be grasped by these legs and impaled on the spikes by the closure of the femoro-tibial joints. The male copulatory organ is repeatedly everted, releasing an odour. Females show similar, though weaker, grasping movements, as their metathoracic legs are thinner and less armed with spikes.

Introduction

Adult males of New Guinea Phasmatids of the genus *Eurycantha* have very large spikes on the metathoracic legs ; the use of these spikes in the behaviour of the insect was first noted briefly by Montrouzier (1855).

An opportunity was taken recently to restudy this matter ; the present paper describes the behaviour in considerably more detail than was given by Montrouzier and includes new aspects. Knowledge of the biology of the insect, of its morphological adaptations and of the circumstances in which the behaviour to be described occurs, suggests that this behaviour is defensive. But in the absence of experimental tests with predators it should strictly be referred to as *presumed* defensive behaviour (Robinson, 1969) ; however for convenience the word *presumed* is omitted.

Morphological Details

Montrouzier (1855) described his *Eurycantha* material as *Karabidion horrida* ; however the generic component of this name is a synonym for *Eurycantha*, the name *Eurycantha horrida* Boisduval, 1835, having priority. The morphology was discussed by Gurney (1947) and brief mention is made here only of certain morphological details which are important to the description of the defensive behaviour. Both sexes are of a dark chocolate brown colour, measure 11–13 cm long and approximately 2 cm wide, and are apterous. The femora of the metathoracic legs of the males are much larger and heavier than those of the other legs, and bear four backwardly directed sharp spikes which are absent from the other legs. The third spike is approximately 1·1 cm long, the others 0·3–0·4 cm. The hind tibia bears a conspicuous ventral tooth approximately 1 cm from the femoro-tibial joint. The tenth abdominal tergite bears a small roughly triangular tooth at each side and the eleventh forms the median triangular epiproct. The posterior edge of the ninth sternite also bears a median tooth.

* FAO Rhinoceros Beetle Project, c/– Koronivia Research Station, Nausori, Fiji.

The females are thick bodied, with the metathoracic femora much thinner than in the males and all the spikes much smaller, being only approximately 0·25 cm long.

The related *Eurycantha calcarata* Lucas 1872 is similar to *E. horrida* in most characters, differing principally in lacking the ventral tooth on the hind tibiae.

Occurrence in the Field

Eurycantha horrida or *E. calcarata* occurred in groups inside hollows in the bases of living trees and specimens were collected in these habitats in the forest near Lowlands Agricultural Experiment Station, New Britain (Pl. xxiv, fig. a). At the time these collections were made the distinction between the two species was not realised. So it is not possible to state whether both species occurred together in the same habitats or whether they occurred in unispecific groups. In a hollow in one tree were one male and eighteen adult females, also four male and six female nymphs. Other trees contained respectively three male adults and ten female adults, one female nymph and the remains of a dead female adult ; one male ; one male and one female ; two males and two females ; one male.

In a garden, two adult females of *E. horrida* were found inside a hollow pipe and were forced to emerge when water was poured in. There were feeding marks on nearby ornamental croton plants (*Codiaeum variegatum* L. Blume var. *pictum*). Presumably the insects emerge from the hollow tree trunks or shelters at night to feed on foliage, but this was not checked by observation.

At Panameko, New Ireland, three males of *E. calcarata* were found in the axils of fronds of young coconut palms.

Rearing and Maintenance in the Insectary

Eurycantha could be maintained readily in cages with branches of croton foliage in jars of water as the food plant. During the day the insects lay dormant in a mass on top of each other on the floor of the cage (Pl. xxiv, fig. b). At night they became active, moving about and feeding. The cages were kept in an insectary, the diurnal temperature of which ranged from 21–35°C.

Defensive Behaviour

Eurycantha horrida and *E. calcarata* were similar in their behaviour. When an adult male was disturbed by being prodded, the abdomen was raised and curled up over the back and the one lower and three upper " teeth " at the end of the abdomen resembled open jaws. The ventral surface of the abdomen was then seen to have a series of white transverse segmental bands (Pl. xxiv, fig. c). The metathoracic legs were lifted clear of the ground and extended wide apart. If the insect was further stimulated or picked up, the metathoracic legs were swung together in a grasping motion. If a finger was held in their path, it was caught in the spikes and then locked within the angle of the femur and tibia either of the one leg by the closing together of femur and tibia like a nutcracker, or of both legs acting together in the same way. The femoral spikes were thus driven into the flesh and locked there so powerfully that blood was drawn, causing a very painful sensation. If however nothing was in their path, the legs were swung together two or three times, or once following each stimulation.

If the insect standing on the ground was touched on the antennae, it swung part way round so that the upraised abdomen and extended metathoracic legs were brought partially to face the source of the disturbance. At the moment the defensive behaviour was given, the membraneous copulatory (phallic) organ, dark purple in colour, was repeatedly everted and a noticeable odour was emitted. A very small amount of brown liquid could be collected by dabbing the everted

copulatory organ with filter paper ; the liquid had the same odour as was noted during the defensive reaction. A specimen in which the copulatory organ has been pulled into the everted position is shown in Pl. XXV, fig. a. Some specimens were dissected and traces of material with the characteristic odour could be obtained from the interior of the infolded copulatory organ (Pl. XXV, fig. b).

When an adult *Eurycantha* female was disturbed, the abdomen was raised vertically, displaying a large white band representing the tergosternal membrane down each side and a series of white transverse segmental bands representing the intersegmental membranes (Pl. XXV, fig. c). The metathoracic legs were raised clear of the ground and struck together several times, or once each time the abdomen was touched. If a finger was inserted, the tibiae would close on the femora, but since these legs were much thinner and the spikes much smaller than in the males, the spiking effect was much weaker. No odour was noted during the defensive reaction of the females. At times when disturbed the insects simply walked away with abdomen upraised.

After stimulation of both sexes for two or three minutes the insects became unresponsive and walked away.

Discussion

The circumstances in which the behaviour of *Eurycantha* described here occurs, strongly suggest that it is defensive in function. The behaviour is given only when the insects are molested and is not seen if they are left undisturbed. It has not been seen to be given prior to mating, as a means of attracting the opposite sex. Robinson (1969) suggested that insect anti-predator adaptations could be classified into two broad functional categories :

1. Primary defence systems which reduce the probability of a predator initiating a prey-capture attempt (adaptations which conceal the insect or which advertise its real or apparent unsuitability as food).

2. Secondary defence systems which operate after the initiation of a prey-capture attempt and which reduce the probability that the attempt will be successful (systems of active escape, anti-predator displays, defensive chemical secretion, flash coloration and death feigning).

The defensive behaviour of *Eurycantha* includes both these defence systems. The primary defence consists of cryptic behaviour, the insects hiding inside hollow tree trunks during the day. Procrypsis may be aided by the brown colour. The heavily indurated, spiny character of the integument of the whole body must also be regarded as protective. If a prey-capture attempt is made, the secondary defences come into play in two successive phases. First comes the display—the rearing up of the end of the abdomen, the rapid working of the copulatory organ with the emission of the odour in the males, and the striking together of the metathoracic legs. If the attack persists and the insect is seized, then the final defensive phase is active counter-attack with the spikes of the metathoracic legs.

The use of the legs in defensive behaviour is not very common in phasmatids. Two Australian species, *Eurycnema goliath* Gray and *Tropidoderus childrenii* Gray strike the metathoracic legs together during pseudaposematic startling displays (Bedford and Chinnick, 1966). The Panamanian species *Onctophasma martini* Griffini, if seized, flexes the posterior legs at the femoro-tibial joint and thus drives the femoral spines into the restraining object (Robinson, 1968) in the same way as *Eurycantha horrida*. The wingless *Dryococcelus* (formerly *Karabidion*) *australis* Montrouzier, which once occupied Lord Howe Island and is closely related to *Eurycantha*, sheltered during the day in groups in hollows inside living trees. When captured, males used the large spines on the hind femora in conjunction with the strongly curved tibiae (Lea, 1916) again in a manner similar to *Eurycantha*.

Curvature of the abdomen dorsally occurs during defensive behaviour in *E. goliath* and *T. childrenii* (Bedford and Chinnick, 1966), and in *O. martini*, in reference to which Robinson (1968) considers the display to resemble to some extent the movements made by scorpions prior to stinging. In males of the mantid *Angela guianensis* Rehn, the abdomen during display is swept forwards (dorsally) towards the head in a series of bowing movements, and at the same time the foliaceous anal cerci are opened outwards, revealing their previously concealed yellow inner surface in a conspicious way (Robinson, 1969). In *E. horrida* males, the abdomen is reared dorsally in an S-shape and at the same time the copulatory organ is worked rapidly in and out, the whole perhaps resembling the rearing of a serpent's head with opened jaws and flickering tongue.

Referring to *O. martini*, Robinson (1968) stated that " if the display and the use of the femoral armature are to be regarded as defensive, it is necessary to explain why they are most highly developed in males and almost absent in females ". He suggested that males may wander considerable distances in search of females and so may be more exposed to predation ; thus they could have been the subject of selection pressure favouring the evolution of stronger lines of defence. Similar reasoning may apply to *Eurycantha*. Very occasionally, dead intact males have been seen lying on the ground in the open where they must have been moving about, whereas dead females were not seen. There is another possibility : the occurrence of both sexes together with immature stages in groups or " colonies " inside discrete shelters such as hollow stumps and tree trunks, could mean that the presence of the males confers some " protection " on the less endowed females and immatures, the males acting as " defenders " of the " colony " as a whole if danger threatens.

The fact that *Dryococelus australis* almost became extinct on Lord Howe Island following the introduction of rats (Smithers, 1970) emphasises the fact that a defensive mechanism may fail against a predator better equipped than those in whose presence it was evolved.

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EXPLANATION OF PLATES

Plate xxiv

Fig. a. Felled hollow tree trunk at Keravat, New Britain, in which *Eurycantha* were found.
Fig. b. *Eurycantha* adults dormant on cage floor during daytime.
Fig. c. *Eurycantha horrida* male in defensive posture.

Plate xxv

Fig. a. End of abdomen of freshly dead *Eurycantha* male with copulatory organ (CO) pulled out.
Fig. b. Dorsal dissection of *Eurycantha* male showing infolded copulatory organ (CO).
Fig. c. *Eurycantha horrida* female in defensive posture.